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ABSTRACT

Thirty-two intellectually superior and 32 intellectually normal fifth and sixth graders were compared on measures of attention and comprehension of complex verbal stimuli under successive versus simultaneous modes of presentation. Ss were exposed to either successive or simultaneous presentation of printed short stories on slides. Analysis of comprehension tests indicated a significant difference between ability groups on both conditions, with a greater difference favoring the superior students under the simultaneous condition. Results had implications for theories of attention and information processing. (CL)

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COMPREHENSION OF SIMULTANEOUS STIMULI IN NORMAL AND SUPERIOR CHILDREN

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Comprehension of Simultaneous Stimuli

in Normal and Superior Children

Abstract

This presentation focuses on the role of intelligence in divided attention and comprehension of complex verbal stimuli under successive versus simultaneous modes of presentation. Normal and superior elementary school children participated in either a successive or simultaneous visual presentation of the stimulus material (two short stories). There was a significant difference between ability groups on both conditions, with a greater difference favoring the superior students under the simultaneous condition. Differences in processing strategies employed by superior and average children as well as implications of this research for the various theories of attention are discussed.

Comprehension of Simultaneous Stimuli in Normal and Superior Children

Although much work has focused on the learning processes of young children and how these processes operate, relatively little new information has been generated on the differences between children of normal intelligence and children of superior intelligence regarding these processes. It is generally assumed, with some empirical validation (Bruch, 1975; Gallagher, 1975), that intellectually superior children are more capable of successfully performing complex cognitive tasks than are children of average intelligence. The issue of concern in the present study is whether differences in human intellectual capabilities are exhibited in differences in learning rates when material is presented simultaneously.

Bruch (1975) and others (Drews, 1972; Gallagher, 1975) have noted the dearth of studies dealing with intellectually superior children. There is a lack of research on gifted children in the area of cognitive development and in specialized research areas such as learning, perception, and language acquisition. A review of recent research on language acquisition (Ruder, Bricker & Ruder, 1975) made no mention of studies relating to the compre-

hension and use of more complex syntactical structures by intellectually superior children. Similarly, research directed to attentional processes and retention in gifted children is absent.

In addition to the studies that are concerned primarily with the learning and retention of meaningful material (Gagné, 1969; Kintsch & Monk, 1972; King & Greeno, 1974), there is a separate line of research that attempts to penetrate the problems of comprehension and retention. In an effort to determine whether the nature of attention is unitary or multiple or a combination, depending upon the particular task and circumstances, these studies have investigated the ability of humans to process information simultaneously. The basic question being studied is: Can two simultaneous but unrelated inputs be processed at the same time? Kahneman (1973) has shown that the various theories of attention imply different answers to this question. The details and complexities of the various theories of attention are essentially beyond the scope of the present study. However, since the majority of studies of divided attention have used verbal material as stimuli, certain conclusions are relevant to the present topic.

Mowbray (1953) had subjects listen to one story while reading another. On the comprehension tests, the second channel

scores were consistently near chance, suggesting that the subjects were concentrating on only one of the passages. Mowbray's findings are consistent with Kahneman's (1973) observation that responses to simultaneously presented items frequently fail. Kahneman reported that studies find a negative correlation between responses to simultaneous items because the subject responds to one of the stimuli but remains unaware of the other.

A related issue is whether concurrent tasks presented in different sensory modalities are more difficult than concurrent tasks presented in the same modality. The evidence indicates that tasks involving the same modality become disproportionately more difficult when performed simultaneously (Burrows & Solomon, 1975; Salthouse, 1975; Kahneman, 1973; Treisman, 1969).

It is apparent that little experimental information currently exists relating to the processes operating in the cognitive development of intellectually superior children. While there are memory items included in virtually all of the standardized intelligence tests, there is nothing in these tests that attempts to gauge an individual's possible ability for simultaneous processing and comprehension of stimuli.

The present study was formulated for two purposes: (a) to shed some light upon the question initially suggested by Bruch

(1975, p. 258), "Are the gifted able to attend to simultaneous stimuli and apprehend cognitive complexity without loss of information?" and (b) to generate basic information regarding differences in learning by investigating the variables of sex and intelligence as they relate to the ability to respond to simultaneous stimuli.

Method

Subjects and Design

The subjects were 64 fifth- and sixth-grade children selected from four schools in a school district in Oregon. These schools were selected as representative of a broad cross-section of the district school population.

Nineteen subjects were in the fifth-grade and 45 were in the sixth-grade. Thirty-two were females and 32 were males. The subjects were divided into two ability groups. Those individuals designated as intellectually superior (n = 32) had obtained an IQ score of 130 or higher on the Stanford-Binet, or its equivalent, and had been admitted into the Educationally Advanced program for gifted students in their school district. Students selected for the program are reported as representing the upper five percent of the school population in general intellectual ability.

Individuals designated as having normal intelligence (n = 32) were established as such by virtue of their achievement test scores and the recommendation of a teacher or principal. Though it was not the policy of the school district to administer intelligence

tests, there were a number of normal students on whom IQ data was available. For these students, the IQ scores ranged from 93 to 111, within the range of normal intelligence. All students who participated in the study were at or above grade level in reading ability.

Following selection, all students were randomly assigned to the comparison and control groups. Each student served in one of the following conditions: (a) successive presentation of the stimulus material, or (b) simultaneous presentation of the stimulus material. The research design was a two-group model with randomization of conditions.

Apparatus and Materials

Physical apparatus consisted of a Kodak Carousel 800 Slide Projector and screen. Total time of exposure and density of material was controlled across the experimental and control conditions. The speed of presentation was five seconds per slide and was determined by a pilot study.

The printed material on the slides consisted of two short stories selected from a nationally standardized achievement test at the grade level appropriate for the students. The use of nationally standardized material provided stories and questions with validity and reliability having already been firmly established.

One set of slides consisted of two short stories of comparable length but differing content. These stories were presented

separately, one story at a time. Each story consisted of 12 slides. The students were presented with an eight-to-ten-word section from the story on each slide. This arrangement prevented forward and/or backward glancing by the subjects.

The second set of slides consisted of the same stories as Set One. The two stories appeared on the slides simultaneously. The students were presented with a four-to-five-word section from each of the stories on each slide. Simultaneous presentation of the stories required 24 slides. The format of presentation of the stimulus material closely followed that of Carver (1970).

The dependent variable was two seven-item multiple-choice comprehension tests administered after presentation of the stories. The items were identical across conditions.

Procedure

Subjects were tested in small groups by the investigator. The median group contained five students.

Students in the control group (n = 32) participated in successive presentation of the stimulus material. All students in the experimental group (n = 32) participated in simultaneous presentation of the stimulus material. Half the subjects in each group were of superior intelligence, and half were normal.

The procedure for the control group was:

1. Read Story A.

2. Write down the two main points of Story A.

3. Take the comprehension test on Story A.

4. Read Story B.

5. Write down the two main points of Story B.

6. Take the comprehension test on Story B.

Sixteen students read the stories in the order listed above. Sixteen students read the stories in the reverse order. Subjects were assigned to these conditions randomly.

The procedure for the experimental group was:

1. Read Story A and Story B simultaneously.

2. Write down the two main points of each story.

3. Take the comprehension test on both stories.

The position of the stories was alternated among the subjects. Sixteen students viewed Story A on the left side of the slide and Story B on the right side. The other 16 students viewed Story B on the left side of the slide and Story A on the right side.

At the conclusion of both conditions, the subjects answered questions pertaining to their perception of the task. The students who viewed the stories simultaneously were asked what strategies were used to keep the stories straight.

As an additional measure of evaluating comprehension of the stimulus material, the students were requested to write down the

two main points of each story prior to taking the comprehension tests. The investigator desired to know how well the students had grasped the main ideas of the stories before exposure to any test items.

Results

The means and standard deviations of the dependent measure are presented in Table 1 by sex and classification of students. Mean scores on Condition One (successive presentation of stories) for superior subjects, normal subjects, and both groups combined were 13.56, 12.63, and 13.09, respectively. Scores for the superior students ranged from 12 to 14, with a maximum possible of fourteen. Scores for the normal students ranged from 9 to fourteen.

Insert Table 1 about here

Mean scores on Condition Two (simultaneous presentation of stories) for superior subjects, normal subjects, and both groups combined were 12.06, 9.63, and 10.84, respectively. On Condition Two superior students' scores ranged from 10 to fourteen. The normal students' scores ranged from six to thirteen.

The overall test of significance was tested using a 2 x 2 x 2 factorial analysis of variance.

Results of the analysis revealed no significant differences between sexes on the main effect or with a triple order interaction. Mean scores for females and males did not differ significantly under either condition of stimulus presentation.

The data analysis revealed a significant interaction effect between intelligence and the experimental conditions ($\underline{F}$ (1, 63) = 4.71, $\underline{p} < .03$). As can be seen from Table 2, the two interactions of sex x intelligence (A x B) and sex x condition (A x C) contributed to the significant interaction of intelligence x condition (B x C). Table 2 also presents the levels of r_m, magnitude of experimental effect (Friedman, 1968). From the obtained r_m values, it can be seen that while the analysis revealed a strong effect for subjects, the largest effect was the condition ($\underline{F}$ (1, 63) = 42.41, $\underline{p} < .0001$).

Insert Table 2 about here

T-tests revealed significant differences in mean scores between the superior subjects and the normal subjects on both conditions ($\underline{t}$ (30) = 2.82, $\underline{p} < .01$; $\underline{t}$ (30) = 3.98, $\underline{p} < .01$).

As predicted, both superior students and normal students had more difficulty with the simultaneous presentation of the stimulus material than with the successive presentation of the stories. There

was a significant difference between the two ability groups on both conditions, with a greater difference between the groups on Condition Two (simultaneous presentation). The difference between the groups on Condition One was reliable, but small.

The students' responses to the main points of the stories were evaluated for general comprehension of the stimulus material. The four "main point" responses highest in frequency were observed. These four main ideas were then used as the criterion for administering scores to the subjects. Thus, each subject received one point for each response that matched with one of the four most frequent responses.

The analysis of the main idea data replicated the main effects found in the analysis of the comprehension test data. There was a significant difference between the two ability groups on both conditions, with a greater difference favoring the superior subjects under the simultaneous condition. The second order interactions were not significant at an alpha level selected at .05. The triple order interaction was significant at the .006 level (F (1, 63) = 8.24, $p < .006$).

Discussion

The hypothesis that there is a significant relationship between intelligence and the ability to attend to and comprehend

simultaneous visual stimuli received support in the direction expected. Intellectually superior students performed more successfully than normal students under both successive and simultaneous presentation of the stories. The gifted students appeared more capable of responding to and comprehending simultaneous visual stimuli than the normal students.

The children who participated in the simultaneous presentation condition were asked to explain what strategies, if any, they used to keep the stories separate. While the most frequent response was in the vein of "I remembered what I read," several specific strategies were apparently put to use by many of the students.

Several students responded that they read the story on the left side first on each slide. It was anticipated that this method of reading the stimulus material would be the predominant strategy response because it reflects the fact that individuals in this society are taught to read from left to right. Thus it might be argued that it was the natural tendency of the students to respond to the stimulus by reading the left side of the slide first.

There were a number of subjects who deviated from this response and approached the stimulus material differently. A few students commented that they read the story on the right side first. One strategy in particular was adopted by several students. On the first slide, they read the story on the left first and then the

story on the right. On the next slide, they read the story on the right first. This left-right, right-left procedure was followed for the entire presentation.

All of these strategies reflect the same basic approach: though presented simultaneously, the stories were handled successively. No subject remarked that he or she was able to respond to both stories at once. Rather, all of the strategies reported involved successive handling of the material. This finding is consistent with the observations of Das (1973) and Luria (1966a, 1966b). Verbal comprehension, Luria suggests, depends mainly on successive integration.

In reviewing the evidence for two types of information processing, successive synthesis and simultaneous synthesis, Das concluded that rote memory or associative learning tasks tend to require successive processing. More complex verbal tasks involving reasoning and abstraction need simultaneous processing.

Das (1973) has also commented that intelligence is not marked by a preference for either mode of information processing. It is not possible to conclude from the present study whether intelligence is or is not marked by a preference for one mode of information processing. However, intelligence does appear to affect the degree to which an individual is capable of attending to and comprehending

complex visual stimuli when they are presented simultaneously. If individuals of normal intelligence are more capable of successive processing than of simultaneous processing, it might be expected that they would exhibit a preference for the successive mode of information processing.

An alternative explanation for the present finding exists. The intellectually superior students had higher percentile scores in reading vocabulary and reading comprehension than the normal students. Though there was little difference between the two groups of students on the successive presentation of the stimulus material, the possibility of significant differences in reading ability may have accounted for the superior performance of the gifted students in the simultaneous condition. It may be that the independent variable is a complex form of intelligence test.

The present study has helped to generate new information concerning the abilities of individuals to attend to and comprehend complex simultaneous stimuli. The examination of the relationship between this ability and intelligence adds to our present understanding of the cognitive abilities of both normal and intellectually superior children.

Future studies in this area should vary the difficulty of the stimulus material, as well as the speed of presentation (e.g., reduce exposure to three seconds per slide or to the individual

subject's reading rate). Additional investigations might produce new ideas for devising comprehensive test items that would tap an individual's ability for simultaneous processing of information and comprehension of simultaneous stimuli, and otherwise help to identify distinctive abilities at the higher levels of intelligence.

Table 1

Means and Standard Deviations of the Dependent Variable By Sex and Classification of Subjects

	Condition One (successive)			Condition Two (simultaneous)			Combined Conditions		
Group	n	M	SD	n	M	SD	n	M	SD
Superior Ss	16	13.56	0.61	16	12.06	1.20	32	12.81	1.21
Females	8	13.63	0.70	8	11.50	1.23	16	12.56	1.46
Males	8	13.50	0.50	8	12.63	0.86	16	13.06	0.83
Normal Ss	16	12.63	1.11	16	9.63	2.06	32	11.13	2.22
Females	8	13.13	0.60	8	9.50	1.67	16	11.31	2.20
Males	8	12.13	1.27	8	9.75	2.40	16	10.94	2.25
All Ss	32	13.09	1.01	32	10.84	2.07	64	11.97	1.98
Females	16	13.38	0.70	16	10.50	1.77	32	11.94	1.96
Males	16	12.81	1.19	16	11.19	2.30	32	12.00	1.99

Table 2

Summary of 2 X 2 X 2 Factorial Analysis of Variance on Comprehension Test Scores (n = 64)

Source	SS	df	MS	F	p	r_m
Sex (A)	0.07	1	.07	-	-	-
Intelligence (B)	45.57	1	45.57	23.86	0.0001	0.55
Condition (C)	81.00	1	81.00	42.41	0.0001	0.66
(A) X (B)	3.05	1	3.05	1.60	0.21	0.17
(A) X (C)	6.25	1	6.25	3.27	0.08	0.23
(B) X (C)	9.00	1	9.00	4.71	0.03	0.28
(A) X (B) X (C)	0.00	1	0.00	-	-	-
Within	107.00	56	1.91	-	-	-
Total	251.94	63				

Note. r_m = magnitude of experimental effect (Friedman, 1968).

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Footnotes

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